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First collected specimen of *Trachycephalus hadroceps* (Duellman & Hoogmoed, 1992) (Anura, Hylidae) from Brazil

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Abstract

We report the first collected specimen of *Trachycephalus hadroceps* (Duellman & Hoogmoed, 1992) from Brazil. This record, from the municipality of Porto Grande in the state of Amapá, expands the geographic distribution of this species by approximately 230 km south-southeast from the nearest previously known locality at Camopi, French Guiana. We also provide data on the advertisement call of the species.

Keywords

Advertisement call, Amazonia, distribution extension, Lophyohylini

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Introduction

The hylid genus *Trachycephalus* Tschudi, 1838 is represented by 18 species of frogs distributed from the lowlands of Mexico, throughout Central and South America to northern Argentina and eastern Brazil (Frost 2021). To date, 14 species of *Trachycephalus* are known to occur in Brazil (Blotto et al. 2020; Segalla et al. 2021), with the following species occurring in Amazonia: *T. coriaceus* (Peters, 1867), *T. cunauaru* Gordo, Toledo, Suárez, Kawashita-Ribeiro, Ávila, Morais & Nunes, 2013, *T. hadroceps* (Duellman & Hoogmoed, 1992), *T. helioi* Nunes, Suárez, Gordo & Pombal, 2013, *T. resinifictrix* (Goeldi, 1907), *T. typhonius* (Linnaeus, 1758), and *T. venezolanus* (Mertens, 1950).

Among them, *T. hadroceps* is one of the least known

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species because it is strictly associated with tree cavities at high heights, and therefore it is rarely directly observed (Lescure and Marty 2000; Moser 2010). Males usually use tree holes as calling sites to attract females, and the eggs are deposited in the water accumulated in these cavities (Lescure and Marty 2000; Moser 2010). The tadpole of this species is exotrophic (see Haddad and Prado 2005 for the genus *Phrynohyas* = *Trachycephalus*). *Trachycephalus hadroceps* is restricted to the part of Amazonia north of the Amazon River, in the eastern portion of the Guiana Shield, with known occurrences from southern Guyana (where the type locality is located), southern Suriname (Fouquet et al. 2015), and throughout French Guiana (Fouquet et al. 2019; Dewynter et al. 2020; Vacher et al. 2020). It has been suggested that *T. hadroceps* could possibly also occur in adjacent Brazil (Nunes et al. 2013; Frost 2021). Avila-Pires et al. (2010) reported that the call of this species was heard in the Reserva Biológica Maicuru, state of Pará, but the call was not recorded, and no specimen was observed or collected. The only published account on this species' advertisement call is the brief description provided by Lescure and Marty (2000).

Herein, we report for the first time the collection of a specimen of *T. hadroceps* in Brazil. This record was made in the state of Amapá, northern Brazil, and extends the geographic distribution of this species south-southeast from the nearest previous record in French Guiana. In addition, we provide data on the advertisement call of this collected individual, and an updated distribution map for this species.

Methods

We conducted field surveys from 15 to 20 March 2021 in the municipality of Porto Grande and surroundings (Fig. 1). During these surveys we visually and acoustically searched for amphibians in possible breeding sites. A specimen was heard calling in a cavity high (>15 m) in a tree and collected by a field assistant who climbed the tree with the help of ropes. The specimen was collected in Module I in the fauna monitoring campaign of the Cachoeira Caldeirão Hydroelectric Power Plant, which was carried out by the company Biolex Consultoria Ambiental. The specimen was euthanized with 5% lidocaine, fixed in 10% formalin, and stored in 70% ethanol. Before fixing, we collected muscle tissue samples from the specimen and stored them in 100% ethanol. The voucher specimen was deposited at the Herpetological Collection of the Universidade Federal do Amapá (CECC), in accordance with the Instituto Chico Mendes de Conservação da Biodiversidade/Sistema de

Figure 1. Known records of *Trachycephalus hadroceps* (black circles), including its type locality (black square) in Acarai Mountains, west of New River, Guyana, and the new record (yellow star) in Porto Grande, state of Amapá, Brazil. Black diamonds are acoustic records (call heard but not recorded; see Discussion). The inset shows a close-up of the locality of the new record, with the Cachoeira Caldeirão Hydroelectric Power Plant represented by a red square.

Figure 2. Live adult male of *Trachycephalus hadroceps* (CECC 3626; SVL 53.5 mm) from Porto Grande, state of Amapá, Brazil, in dorsolateral (left) and ventral (right) views.

Autorização e Informação em Biodiversidade (ICMBio/SISBIO permit #48102-3). In order to provide an update on the distribution of this species, we produced a map using Google Earth and QGIS software (QGIS Development Team 2017) and incorporated geographic coordinates obtained from our herpetological surveys and the literature (Avila-Pires et al. 2010; Fouquet et al. 2015; Fouquet et al. 2019; Dewynter et al. 2020; Vacher et al. 2020).

Bioacoustics. Advertisement calls emitted by the collected male (voucher CECC 3626) were recorded with a Shotgun NTG1 RODE microphone coupled to a TASCAM DR-40 digital recorder (sampling rate of 44.1 kHz; 16 bits resolution). The microphone was positioned at a distance of more than 15 m from the individual because it was calling within a very high cavity of the tree. A 200-Hz high-pass filter and a 4000-Hz low-pass filter were applied a priori to the sound file in order to reduce background noise, and then the recording was normalized (peak −1.0 dB) using Audacity v. 2.2.2 software (Audacity Team 2020). Call analyses were conducted in Raven Pro v. 1.5 software (K. Lisa Yang Center for Conservation Bioacoustics 2014) with the following settings: window size = 512 samples; 3dB filter bandwidth = 124 Hz; window type = Hann; overlap = 50% (locked); hop size = 5.80 ms; DFT size = 1024 samples; grid spacing = 43.1. The following call traits were measured following the acoustic terminology and definitions of Köhler et al. (2017), based on the note-centered approach (i.e., each call corresponds to a single note): temporal traits (note duration, inter-note intervals, note rate); spectral traits (dominant frequency, minimum frequency, maximum frequency, note bandwidth; respectively measured with the functions Peak Frequency, Frequency 5%, Frequency 95%, and Bandwidth 90%). Sound figures were generated in R platform v. 3.6.2 (R Core Team 2019), using seewave v. 2.1.6 (Sueur et al. 2008) and tuneR v. 1.3.3 (Ligges et al. 2018) packages with the following settings: window = Hanning; overlap = 50%; FFT = 512. The analyzed sound file (label: Trachycephalus_hadroceps_CECC_3626_19_03_2021) is deposited in the Herpetological Collection of the Universidade Federal do Amapá (CECC) and in the Fonoteca Neotropical Jacques Vielliard (FNJV) (catalogue number 50513).

Results

Trachycephalus hadroceps (Duellman & Hoogmoed, 1992)

Figures 1, 2

New record. BRAZIL – **Amapá** • Municipality of Porto Grande; 00.7345°N, 051.4954°W; 110 m elev.; 19.III.2021; Rodrigo T. Pinheiro leg.; found at night (19:00 h) inside a hollowed base of a tree branch >15 m above the ground; CECC 3626, 1 adult ♂, SVL 53.5 mm.

The specimen was found in the canopy of a sucupira tree, *Pterodon emarginatus* Vogel. The nearest watercourse, approximately 300 m from the collection site, is the Araguari River. The individual started calling at 18:40 h inside a hollowed base of a tree branch. The cavity was located more than 15 m above the ground and was approximately 30 cm deep, 10 cm wide, and filled with water.

Identification. We identified the collected specimen (Fig. 2) as *T. hadroceps* based on the original description by Duellman and Hoogmoed (1992) and the later accounts provided by Lescure and Marty (2000) and Dewynter et al. (2016). The specimen has the following chromatic and morphological diagnostic traits: male with a SVL of 53.5 mm; a single, median subgular vocal sac, not externally visible; snout short and truncate, not extending beyond the margin of the lip; dorsal surface light chestnut, with a dark brown pos orbital area and a large equally dark brown area across middle of the back, extending to the flanks in the axilla and groin, respectively; dorsal surfaces bearing several large and round juxtaposed tubercles; dark brown transversal bars on the

dorsum of the limbs; axillary membrane extending to one half length of the upper arm; toe discs light green; ventral surface greenish, speckled with brown, almost marbled on throat; iris chestnut to beige, with a median, horizontal, brown bar and a thin, vertical, brown bar below the pupil, thus making an incomplete cross.

The advertisement call of this collected individual matches in structure and trait values with the reported for the species by Lescure and Marty (2000). Next, there is a detailed description of the calls emitted by this specimen.

Advertisement call. The call is a short, low-pitched conspicuous sound, consisting of a single note [*n* = one male (CECC 3626); 17 analyzed notes] (Fig. 3), whose structure classifies as pulsatile (*sensu* Köhler et al. 2017) since it has weak and irregular internal amplitude modulations, i.e., poorly defined pulses. Notes last from 73 to 95 ms (mean = 82, SD = 6) and are spaced by intervals that vary from 720 to 970 ms (mean = 800, SD = 70), being continuously emitted at an almost regular rate of 70 notes/min. The dominant frequency ranges from 904 to 1120 Hz (mean = 1077, SD = 61), the minimum frequency from 560 to 861 Hz (mean = 745, SD = 121), the maximum frequency from 1292 to 1680 Hz (mean = 1464, SD = 157), and the note bandwidth from 431 to 1120 Hz (mean = 719, SD = 276).

Discussion

The individual from Porto Grande (Amapá) reported here unambiguously matches the previous morphologic diagnoses provided for *Trachycephalus hadroceps* (Duellman and Hoogmoed 1992; Lescure and Marty 2000; Dewynter et al. 2016), and its advertisement call matches the call description provided by Lescure and Marty (2000). As the latter is a brief acoustic account that described only three call variables (note rate, note duration, and the range of the dominant frequency), we provide additional information on the species' advertisement call. As its call is composed of a short note with pulsatile structure, it is readily distinguished from the calls of other *Trachycephalus* species, which are characterized by longer notes with pulsed structure (Hödl 1991; De la Riva et al. 1995; Abrunhosa et al. 2001; Kwet and Solé 2008; Santos-Silva et al. 2012; Gordo et al. 2013; Zaracho et al. 2018; Provete et al. 2021).

Trachycephalus hadroceps is distributed in the eastern portion of the Guiana Shield, occurring in southern Guyana, southern Suriname (Fouquet et al. 2015), throughout French Guiana (Fouquet et al. 2019; Dewynter et al. 2020; Vacher et al. 2020), northern Pará (Avila-Pires et al. 2010) (Fig. 1), and it has been suggested that it could also occur in adjacent Brazil (Nunes et al. 2013; Frost 2021). Our record of *T. hadroceps* from the

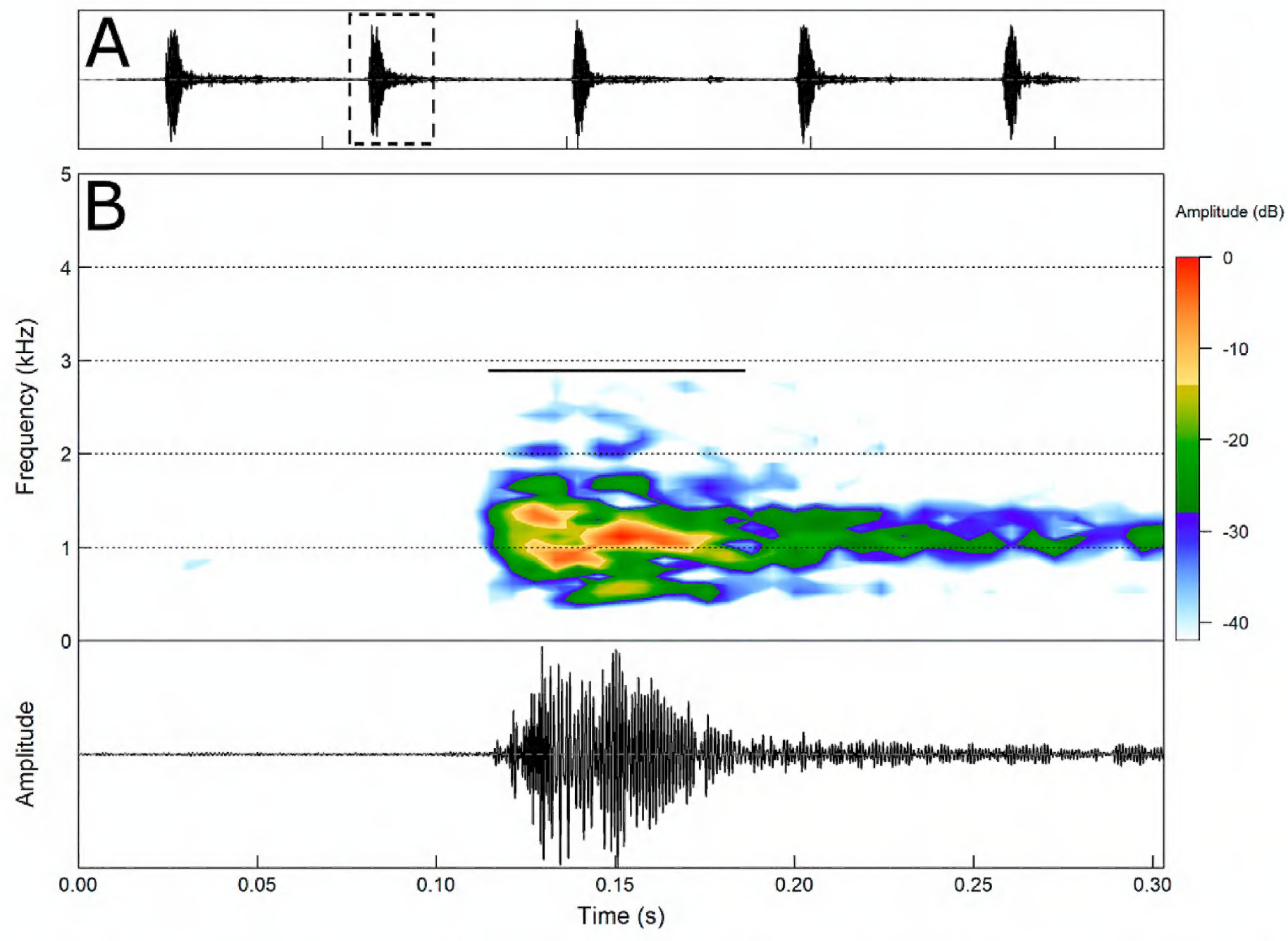

Figure 3. Advertisement call of the collected male (CECC 3626) of *Trachycephalus hadroceps* from Porto Grande, state of Amapá, Brazil. **A.** Oscillogram section (ca. 4.45 s) depicting a sequence of five calls. **B.** Spectrogram (top) and corresponding oscillogram (bottom) detailing the advertisement call highlighted in A; the black horizontal bar in the spectrogram delimits the total call duration.

municipality of Porto Grande represents the first collected specimen and recorded call from Brazil, thus extending the geographic distribution area of this species by approximately 230 km south-southeast from the nearest known locality in French Guiana (Camopi), and by approximately 270 km east from the record in northern Pará. During fieldwork at Reserva Extrativista Municipal Beija-Flor Brilho de Fogo (Amapá; 00.7918°N, 051.9784°W) (Fig. 1), one of us (CECC) heard the call of this species, but no specimen could be collected. *Trachycephalus hadroceps* probably has an even wider distribution across the Eastern Guiana Shield, but it is so difficult to collect that only acoustic identification could more accurately determine its geographic range. This species exemplifies the difficulty in assessing the distribution of arboreal species in tropical forests and more generally of species with low detectability (Kays and Allison 2001; Guayasamin et al. 2006; Fonseca et al. 2020). Given this, the need to generalize the use of acoustic monitoring in biodiversity surveys is therefore highlighted (Sugai and Llusia 2019; Boullhesen et al. 2021).

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Authors' Contributions

Data curation: RTP, VAMBF, JCS, CECC. Formal analysis: AGL, VAMBF, JCS. Methodology: RTP, JCS. Supervision: CECC. Writing – original draft: AGL, CECC, AF. Writing – review and editing: AGL, AF. Visualization: RTP, VAMBF, AGL.

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